To search page

Early 1950's
Germanium (Ge) single crystal
~ Equipment & Materials Table of Contents ~

Bell Telephone Laboratories made Ge single crystals by Czochralski method in the development of Ge rectifiers for radar application during the Second World War. This Czochralski method germanium (Ge) single crystal was used for the point contact type transistor invented by Bell Laboratories in 1947 [1]. The Czochralski method was invented by Jan Czochralski in 1916. A needle-like seed crystal is immersed in the dissolved metal and is slowly pulled up to grow a bar-shaped single crystal.

A high purity germanium (Ge) single crystal was necessary for a junction type transistor, which became mainstream in the 1950 's, having p-n-p junctions which are formed by selectively introducing donor and acceptor impurities. For this reason, the zone-melt method which purifies Ge ingot was developed by William G. Pfann of Bell Laboratories in 1952. Utilizing the property of impurities diffusing to the liquid phase side due to the liquid-solid phase transition phenomenon, one end of the ingot is partially melted, the melting part is gradually moved, and then the impurities are pushed out to the opposite end part. The zone-melt method was later evolved to the floating zone method of forming high purity silicon (Si) single crystals.

Semiconductor manufacturers made their own Czochralski furnaces and zone melt furnaces, thereby produced Ge single crystals in-house and produced transistors. Also in Japan, Sony and Hitachi made their own Czochralski puller furnaces in 1954 and produced Ge single crystals in-house. Furthermore, Kokusi Electric (later Hitachi Kokusai Electric, now KOKUSAI ELECTRIC), which was developing high-frequency induction heating devices and magnetically modulated temperature control devices, received a request from the Electrical Test Laboratory (present Electro Technical Laboratory) and produced Czochralski furnaces (Fig. 1) and zone-melt furnaces and started to sell these equipment in 1957.

Figure 1 Germanium/silicon single crystal pulling equipment
(provided by KOKUSAI ELECTRIC)

References:

【1】W. Shockley “The Path to the Conception of the Junction Transistor” IEEE ED-23 no.7, 597-620, 1976

Version 2022/5/11